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SCIENCE

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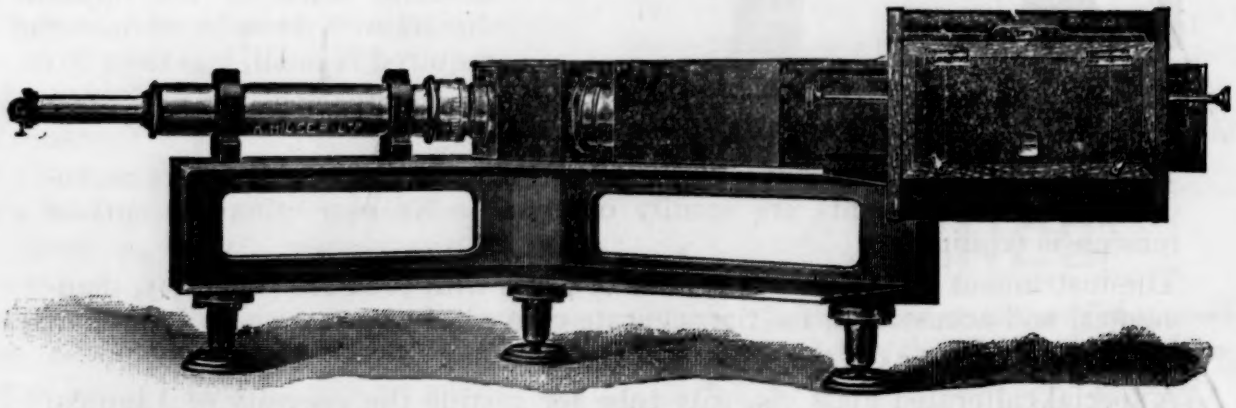

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SCIENCE

FRIDAY, SEPTEMBER 24, 1920

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CONSERVATION OF THE QUALITY OF WATER OF NEW YORK STATE AS A NATURAL RESOURCE

ECONOMIC VALUE OF QUALITY IN WATER

THE original abundance of water in the state of New York, its very commonness, has dulled her people's appreciation of the subtle quality value of their heritage. Momentarily shut off from their supply the cities and industries would instantly realize its vital necessity. Precipitate ruin of the wonderfully rich, living waters of the state would awaken immediate appreciation of their unreplaceable benefits. Coincident with the decreasing quality condition of the waters, grows its greater economic value. The expansion of cities with their manufactures and commerce is dependent on the very water which they threaten, and the wealth flowing from them seeks the natural wealth of the streams, and the food driven from their waters. Consider the millions spent in carrying pure water long distances to the cities, in protection of the watersheds, building and operating filtration plants, and in the disposal of sewage. Consider the millions dependent on clean water at the recreational resorts of the people. Consider the value to manufactures themselves of obtaining water of the proper quality for their processes. Consider the value of fish as unrivaled sport and unreplaceable food, and the value of shellfish industries to the state. Consider, lastly, the expense to the state in guarding these resources and in hatcheries to correct the failure of the waters. Not only may the people be denied the recreational advantages of clean waters, and the return from industries dependent on them, but they must bear the extra burden of obtaining suitable water for their vital necessities. Considering the magnitude of its trust, the state can afford to conserve its interests in the quality of water by using it to her greatest advantage.

NEW PROBLEM

The increased quantity of domestic wastes resulting from the natural growth of population does not account for the rapid deterioration in the quality of the natural waters of New York state. Sewage pollution has been anticipated; it is a time-honored problem of gradual growth; methods of treatment have been developed, and in general it is cared for by municipal disposal plants. Trade wastes, however, from the recent astonishing development of chemical industries, unnaturally supplemented by war demands, have given rise to another and more complex problem. New manufacturing plants have been built along the water courses, and the activity of older ones extended and enlarged. Little time has been left for contemplation of the damage caused by their wastes, or of preventive methods, and, unless immediate measures are taken, a great resource of the commonwealth is threatened.

QUALITY CAPACITY LIMITED

To those who have measured the amount of water with which nature endows a given area, it is obvious that the quantity is limited. Though not so concrete or commonly understood as its quantitative capacity, as for navigations and for the development of water power, its qualitative capacity for these other purposes is no less limited. The amount of contaminating material a water can absorb without injury to its various uses is strictly limited by the rate at which such substance may undergo physical or chemical change; in no other way can water escape the qualitative result of its use. This in turn depends upon the biological capacity of a stream to bring about those changes, and in this sense the waters are alive. Anything which upsets the digestive power of a stream further incapacitates it for discharging its natural functions, until such time as it may recover by increased dilution. There is a strong temptation for users of the water to ignore that fact, because the carrying power of the stream removes the offence from its source, and the natural limits are usually far exceeded before remedial action is considered. Just as in the case of development for water power, the qualitative limits of its natural capacity to be of economic value can be expanded by judicious use and scientific development.

PROPER UTILIZATION

Sufficient knowledge of the principal properties of water will enable the state to most fully utilize its proper value. It does not follow that individuals, communities, or industries, cease to return used waters to their natural drainage channels; nor is it possible by any treatment to return them unchanged. It is clearly recognized that water has a considerable dilution value within which ultimate harm is not done, and that the natural disposal capacity is one of its most fundamental and valuable assets to the state. By this is not meant the ability to carry waste away from one place to afflict another, but a truly legitimate purification function. As such it plays a great part in the economy of nature. There is constantly going on a process of regeneration of inorganic substances to organic, recharging them by the action of sunlight on green plants with the energy necessary in food for the vitality of man and other animals. From the unoxidized organic wastes of our activity must these inorganic salts be reclaimed. Nature has chosen the bacteria and other lower organisms as agents for this purpose. It is for them to prepare the nitrogen and other elements in those wastes for the next crop of vegetation. If they cease to work, these wastes would accumulate unchanged, clog the progress of the organic cycle in nature, and in a short time the earth would become a desert waste. While this activity is not restricted to the water, it particularly concerns America, whose universal adoption of the water system of sewage disposal loses a valuable fertilizer from its natural place on the land. By enriching the vegetation in the waters and furnishing abundant life thereto, it may be again returned to the people as fish and shellfish instead of beef and mutton. Such a broad consideration of conservation may not seem of immediate con-

cern in the practical use of the waters until it is realized that the same activity gives to water its disposal capacity. Without it, waste matters accumulating from the sources would render the stream unusable below. By the suitable adjustment of all factors, therefore, can its greatest benefits be derived. Only under the most exceptional circumstances are we justified in sacrificing all other uses merely to the carrying capacity of the fluid. By jealously guarding its quality and developing its useful capacity the increased burden from communities and industries can be prepared for.

INJURIES TO QUALITY VALUE

The various ways in which the quality value of water may be injured are as diverse as its many uses. Potability, where essential for public water supply, takes precedence over all other uses, and infection becomes the most dangerous injury to water. Though industrial waste seldom in itself carries infection it may in other ways by giving disagreeable odors, unpalatable taste, or objectionable color and appearance, render it unfit for drinking purposes. Furthermore, it may render purification difficult, thereby overload filtration the health of the community rests; or it may so hinder the proper functioning of sewage disposal plants as to place such a burden on the stream as to make it an impossible supply for the community. Less important, but more obvious, it is necessary for each industry to have an abundant supply of water relatively free from particular substances. For wool scouring it is lime salts; for the manufacture of fine paper it is discoloring material; and so with each industry there are some substances to be avoided. This often determines the location of an industry, and though it may be possible to treat the water in many instances, preventive measures where small concentrations entail widespread injury may be the simpler and cheaper method. There are changes in the water such as to render it unfit for boating, swimming and other recreational purposes. These effects are readily appreciated by the public, who should be anxious to support action where a public attraction becomes an open offense to public decency because some private interest wishes to monopolize a great asset for the smallest use. An enterprise which does not compensate the state for its injured interests is a deficit, and it should be the duty of conservation to prevent a selfish theft.

EFFECT ON FISH LIFE

The Conservation Commission already has been intrusted with the enforcement of laws to prevent the introduction of deleterious substances in quantities injurious to fish life. Such effect is evident where acids or poisonous wastes kill adult fish, or foreign substance may render shellfish unattractive to the consuming market. If the oxygen dissolved in the water becomes greatly diminished the fish will suffocate. Water is to fish what the ground and air combined are to land animals; it furnishes the oxygen for respiration as well as the food they eat. Organic wastes have the power to absorb the oxygen from the water and make it uninhabitable for fish life. Such an oxygen demand can be readily determined and its effect on the stream studied and predicted. Similarly those wastes which hurt the production of fish food indirectly eliminate fish from the water and its absence can not be attributed to overfishing; and anything which drives away the fish has the same effect as removing them in other ways.

Less evident, but equally important is the effect upon the development of the young, the ruin of hatching areas, and the death of the fry which may bring the efforts of the hatcheries to naught. Even though the areas of excessive pollution are localized to greater or less extent they may form pollution dams which interrupt the normal habits necessary to fish propogation. It may be possible to define the quality requirements of different areas in such a way that by artificial assistance each may be used for what it is particularly adapted, to the ultimate improvement of the whole, at the same time giving greater latitude for use of the industries.

LIMITING FACTORS

The injuries enumerated are tangible values which the water may lose. There is, however, the general value of the life in water which is so essential to its preservation for all the various uses. This life constitutes a great biologic equilibrium, delicately balancing a very complex system of factors each dependent upon the other. At any particular time a certain very small factor may determine the condition of the water. The knowledge of what biologists call limiting factors holds the greatest constructive possibilities. If this fundamental principle is thoroughly grasped, it makes evident the great significance of certain wastes under particular conditions, where a limiting factor may be involved, and it shows also the possibility to save a grave situation sometimes by a simple expedient. The most important study in the conservation of the quality of water is thus to determine the specific effect of various contaminating substances upon the limiting factors controlling the biologic equilibrium, and by eliminating them to expand the useful capacity of the streams.

PREVENTIVE METHODS

The scientific problems involved in the treatment of domestic sewage by municipalities have been largely solved. Methods are available for the intensive biologic oxidation of the organic matter so that the subsequent oxygen demand on the stream may be reduced to any prescribed requirements. The same principles may be developed for the treatment of other organic wastes from food producing industries, so that there should be no excuse for the depletion of that great essential constituent of the water. Considerable improvement can be accomplished in many cases by simple changes at little cost. Damage often occurs through thoughtlessness or carelessness, or is due to avoidable accidents. Where the attention of manufacturers has been brought to the serious consequences of such hazard they have been willing to take proper precautions and construct sufficient safety devices. The increased utilization of valuable by-products, by methods well known to industry, has gone far to remove the greatest wastes. Likewise there are corrective processes for settling out or straining out suspended matter, preventing or removing colors, tastes, odors, oil films, etc., and chemical methods for removing or rendering inocuous such deleterious dissolved substances as may work injury to the water. By the conservative application of such methods the improvement necessary to meet specified conditions can usually be attained, if not always with profit, at least without unreasonable hardship.

RESPONSIBILITY OF INDUSTRIES

The responsibility lies with the industries, who receive from the state the benefits from the waters, to study and apply the methods of treatment of their injurious wastes. This has been done in the past because of the value of many of the by-products, and in several of the more progressive concerns laboratories are constantly engaged in reclamation studies. While the possibility of returns has inspired most of these investigations, the knowledge gained leads the way to processes for the protection of the waters, and, in many cases, industries have already realized their responsibilities to the extent of adopting measures for this purpose. The great diversity and complexity of these processes make it impossible, with the limited forces at its disposal, for the state to study each individually, while the extensive chemical facilities of the plants themselves make them not only the responsible, but the logical, places to carry out much of the work. Thus will the scientific knowledge that created the damage also assume the burden of the solution of the problem of its prevention. The federal government is engaged in the study of some of the broader problems of national scope and some states have applied themselves to the solution of certain wastes in which they are particularly concerned. Where the benefits to the state justify the expense, it should be a legitimate function to study the problems which will be of general application to many industries. On the other hand, the generality of the prob-

lem of the effect of wastes upon the waters makes it a peculiarly appropriate field of study for the state and for the authority who should be the responsible judge of the requirements and standards which should apply.

POLICY OF THE COMMISSION

The Conservation Commission desires to take the broadest possible constructive attitude in approaching the problem of maintaining and developing the quality value of the water. Its relations do not bind it to any particular interest or phase of the subject to the exclusion of the others. It can avail itself of the results of the many activities working separately towards conservation of some particular quality value and, by coordinating such activities, temper their demands and supplementing them with a knowledge of changes in the water itself, develop its uses for the greatest benefit of all. The decision on all questions depends upon the particular condition and use of the water and the Commission should be able to avail itself of the best expert knowledge and testimony for sound judgment. In certain phases it will be necessary to establish new standards between those of drinking water requirements and those of common decency. That its rulings and regulations may be fair and trustworthy considerable information must be gathered and investigations prosecuted into the necessity of the measures taken. That the burden on industry or the state may be lessened, discoveries must be gleaned into the unknown possibilities of scientific development. Where prohibitive expense will be required to overcome a natural obstacle which can better be accomplished artificially by fish hatcheries or otherwise, there must the knowledge be available for the conservation of such a resource. In general, therefore, should the state interest itself in and take the action required for the development of scientific *aquiculture* that it may utilize the great water quality resources of the state.

COOPERATION WITH INDUSTRY

It should be evident that the most successful fulfillment of such a program can only be accomplished by active cooperation with the industries. The Commission welcomes, therefore, all opportunities to establish such cordial relations. It aims to become a clearing house for all available information bearing on the common problem. By associating itself with other agencies, in this and other states and the federal government working on the quality of water it can acquire the knowledge obtained by all. It will collect, classify and file for the use of all such methods and data as it may accumulate or discover. Its own investigations will aim to discover the limiting factors which operate to restrict the use of the waters, that corrective measures may be direct and economical. It will publish from time to time such information as may seem of use to the industries as well as to the public. It invites conferences, suggestions and data. In particular is it anxious to assist to the limit of its power the investigations of the industries themselves. At the present time funds are hardly adequate to carry out necessary investigations on the water, but the technical forces will be glad to consult and give any suggestions possible in carrying out such studies.

ASSISTANCE FROM INDUSTRIES

The industries, on the other hand, are in a position to render much honest assistance to the commission in the prosecution of its work. Because of limited funds it will not be possible to carry on its studies on the extensive scale which the magnitude of the problem warrants. The facilities of the various industries would help greatly to attack these problems in earnest, and the working data in their hands will greatly augment the value of the studies.

IMPORTANCE OF TECHNICAL KNOWLEDGE

The industries should be quick to appreciate the necessity of sound technical information. The efficiency upon which their dividends depend is of equal value in exploiting the resources of the water. Waste of its possibilities represents the greatest loss of all. Economy of its value depends upon elimination of what may be discovered to be unnecessary steps or in

the substitution of cheaper or more effective methods. Unintelligent operation is truly false economy, and legislation should not be left to popular caprice, but be tempered and directed by sound scientific knowledge. Especially in such a delicately balanced operation as the scientific control of the natural waters is it necessary to know the facts. Where a small factor can determine the whole condition it is necessary to be familiar with all the details. If a limiting factor can be removed by a simple expedient it allows for expansion all along the line until the next lower factor replaces it. Perhaps this, in turn, may be eliminated with slight treatment, and by successive steps in biological technology can the capacity of the stream be greatly increased with the least expenditure of effort and money.

William Firth Wells
Conservation Commission,
Albany, N. Y.

PLEISTOCENE CLAYS AS A CHRONOMETER

The Swedish expedition now in America, led by Gerard DeGeer, has an ambitious program of proposed discovery. Following are quotations from his announcement:

> . . . the undersigned described how he had, since 1878, worked out and utilized a method of determining by actual counting of certain seasonally distinct laminated clay layers, the chronology of the past 12,000 years, or the period that witnessed the evolution of man as well as of the whole fauna and flora of those parts of northern Europe and North America which during the Ice Age were barren deserts covered by extensive ice sheets, ...
>
> By the new method of investigation it has now been shown to be possible to follow, step by step, how the large ice sheets receded and melted away, this being registered from the melting season of every year by the annual deposition of melting-water sediment, and especially of seasonally laminated clays.
>
> The annual lamina from warmed years being thicker and from colder ones thinner, the chronological self-registering is at the same time a thermographical one. . . .
>
> It will thereby no doubt be possible by a kind of primary triangulation to fix at a sufficient number of points the very years when they passed by the receding ice border. By interpolation between the figures thus obtained and by help of the already mapped moraine-lines, now to be accurately dated, the laws regulating the whole recession of the great ice-sheet can certainly be established and at the same time the rate by which the rideau was pulled away from the stage of life and the amount of time during which in every region of the northern part of the New World the plants and animals have had at their disposal for their immigration and settlement; the time required for the development of the soil and the vegetable mould, for the rivers and the lakes for their erosional work, and for the evolution of our prehistoric ancestor.
>
> . . . . . .
>
> Still, the most far reaching result of the whole investigation might be that so rapid and at the same time so widely distributed variations of the temperature of the air scarcely can be attributed to any other cause than variations in the amount of heat reaching the earth from the sun. . . .

If that program should be promptly carried out the pleasure from scientific discovery by future students will be reduced. Truly, a yardstick of geologic time is greatly desired. More desired than needed. We know that time is long, but how long? The most common question to the geologist is "how long ago?" But if we knew the exact number of years since the ice sheet disappeared from New York, whether 31,676 or 109,322 years it might satisfy some curiosity but would make little difference in human life and race evolution. For we know that geologic time is not to be measured by human standards, and when we deal in millions of years the number of the millions has little significance. The subject appeals to the imagination, especially of the non-geologic public, and if Mr. DeGeer can find out even a part of his program he will make interesting discovery and we applaud the effort. However, lest the public should be too greatly disappointed, it is well to realize some of the difficulties in the study.

The laminated glacial clays which are the subject of measurement were deposited in deep or quiet waters facing the receding front of

the waning glacier. Evidence is found in the excessive lime content, and in the occurrence of large ice-rafted bowlders imbedded in the fine clays. Also, the clays often rest directly on smooth glaciated rock, or on the glacial drift.

The Hudson-Champlain valley is the proper line for the study, and not southern Canada, for in the stretch from New York City to the foot of Lake Champlain, some 300 miles, we have the continuous record of the removal of the Quebec (Labradorian) glacier from the United States. The St. Lawrence valley clays are subsequent in time. Of the long period of ice advance we have no record, nor of its long standstill at the Long Island-Staten Island terminal moraine. The existing record is only that of the diminishing ice sheet and the recession of its border.

The laminated clays were derived largely from the glacial outwash, being the rockflour from the glacial mill. Partly they came from the land wash, by streams eroding the freshly uncovered glacial drift. At the time the clays were deposited the glaciated territory was much lower than to-day, having been depressed by the long-continued weight of the deep ice cap. With the lifting of the burden the land slowly rose. With the land rise the tidal currents and river flow in the shallowing waters swept away most of the clay deposits, or buried them along the sides of the valley under sand and gravel beds. The clays remaining and open to examination are only scattered and minor fragments of the original more or less continuous deposits. These remnants are found along the sides of the valleys; the bulk of the beds which occupied the prisms of the valleys has gone out to the sea.

In the Hudson we have no considerable beds south of Tappan Sea and Haverstraw Bay, although some clays in New Jersey may represent the early time. In the narrow stretch above Peekskill erosion has removed most of the clay, but we find good remnants in the wider valley of the Newburg district. Northward the next massive clays are at Kingston, with only small remnants beyond. In the Albany district and northward the sealevel waters were wide but shallow, and silt and sand plains laid down. In the deeper Champlain Valley massive clays were laid, not only in the broad basin but also in the valleys of tributary streams.

A similar history pertains to the Connecticut Valley and to every deep valley in New England and the maritime provinces having a deep estuary.

The lamination of the clays was produced by interrupted deposition, or variation in the rate of deposit. In the Lower Hudson and in the St. Lawrence the oceanic tides were a periodic factor. In the upper beds of any district the stream inwash of severe storms was an irregular factor. The periodic element on which emphasis is placed is the seasonal variation of the glacial outwash, due to differences of summer and winter melting. In non-tidal areas this may doubtless be discriminated from the superposed day and night variation; and from tidal variation in the open estuary districts. The irregular storm factor may not be a serious complication.

As a time record the clays must be regarded as overlapping, south to north, or as constituting a theoretical vertical column, the southern beds at the bottom of the column and the northern beds at the top. It becomes necessary, therefore, to correlate the laminæ; that is, to determine which particular series of laminæ in a southward section is identical in time with some lower laminæ in a northward section, so as to eliminate duplication. With the fragmentary character of the Hudson-Champlain beds it would seem impossible to identify horizons. And correlation of far separated localities with the indefinite moraine lines will be extremely difficult in either the Hudson-Champlain or the St. Lawrence valley.

DeGeer's estimate of Postglacial time as 20,000 years is certainly an underestimate for America. It should be understood that the ice sheet did not diminish steadily, or the front back away continuously. The ice margin had many oscillations, readvances and reretreats, each probably covering many thousands of years. In the Mississippi Valley between Cincinnati and Mackinac F. B. Taylor has mapped fifteen frontal moraines, each of which

is believed to represent readvance, or at least a long pause in the ice front. For these somewhat regular oscillations no secular cause appears adequate except the precision of the equinoxes, and Taylor figures the time, using the minimum of the precession periods, as 75,000 to 150,000 years. In New York we have many clear proofs of the great length of Glacial and Postglacial time. One of them refers to continental land uplift. Since the glacier passed off from New York the land at the north boundary has risen 740 feet, and that rise is all subsequent to the deposition of the Hudson-Champlain clays, though not to that of the clays of the St. Lawrence.

Any measurement of time by counting seasonal lamination of the Pleistocene clays will require conscientious study of many sections, with the same scrupulous care that Huntington gave to the counting of the growth rings in the California Big Trees.

The clay record, it should be repeated, is only the time while the latest ice sheet was passing off, and that time is only a fraction of glacial time, to say nothing of true Postglacial time.

It is apparent that the proposed study can not be done hurriedly, by reconnaissance and cursory methods. It is the work of a lifetime, and when done is little more than a guess. Possibly such study might develop criteria and methods that would give precision.

To attribute the long-period variation in world climate which produced the Pleistocene Glacial Period, and other vastly more ancient glaciation, to variability in solar radiation is the easiest way of explaining a difficulty. It has no scientific basis. We would better seek causes for climatic changes in the known geologic and atmospheric changes. For this Professor Chamberlin has blazed the path.

H. L. Fairchild

University of Rochester

GENERAL RESOLUTIONS OF THE PAN-PACIFIC SCIENTIFIC CONFERENCE[1]

1. FUTURE CONFERENCES

Since the present conference has been found highly inspiring and illuminating and an invaluable aid in defining the essential problems of the Pacific region, be it

Resolved that future similar conferences should be held at intervals of not over three years.

2. PERMANENT ORGANIZATION

The results of the First Pan-Pacific Conference have demonstrated the high value of meetings for the discussion of problems common to all countries whose interests lie wholly or in part within the Pacific area; and have shown that the problems relating to the welfare of Pacific peoples are too large and too complex to be solved satisfactorily except by sympathetic cooperation of individual institutions and governmental agencies. To develop a unity of interest and to make harmonious coordination practicable, it seems desirable that some permanent organization be established which may serve as the point of contact for representatives of various interests in the countries of the Pacific. Be it therefore

Resolved that the attention of the governor of Hawaii be called to the great opportunity afforded by an organization designed for the advancement of the common interests of the Pacific, including scientific research, and to the desirability of taking action which may lead to the development of such an organization vouched for and supported by the various Pacific countries.

3. INTERNATIONAL RESEARCH COUNCIL

Since this conference commends the organization of the International Research Council as a means toward coordinating research in science; be it

Resolved that it is the desire of this conference that any agency created for the guidance of scientific research and exploration in the Pacific region may be affiliated with the council and with the various national research councils of the nations of the Pacific.

4. SHIPS FOR EXPLORATION

The cost of scientific researches in the Pacific which involve the continuous use of a ship is prohibitive for most scientific institutions and individuals. The results of the *Challenger* and the *Wilkes* expeditions have

[1] Held at Honolulu, August 2 to 20, 1920.

demonstrated the great advantage gained by the use of government-owned ships for scientific exploration. Be it therefore,

Resolved that this conference unites in inviting the attention of governments to the desirability of providing vessels for suitably planned expeditions.

5. PROMOTION OF EDUCATION

The results of scientific research have led to extensions of human knowledge and to increased control of the forces and resources of nature the values of which can not be measured. All scientific work which is well done is of value, and no man can predict to what useful purposes the results of any investigation, no matter how recondite, may be put. It is of fundamental importance that sufficient numbers of young men and women of first class ability shall be adequately trained, and that teachers and investigators shall be properly compensated. This conference therefore, *Recommends:*

1. That in order that young men may enter upon scientific careers without sacrificing all hope of reasonable financial returns, the compensation for instruction and for research in science be increased so that all can at least be assured of a comfortable living for themselves and their families, and that men of exceptional attainments may receive financial rewards which shall approximate those which their powers could command if directed to commercial ends.

2 That persistent efforts be made to inform the public of the progress of science and of its bearings upon the practical affairs of life.

3. That to enlarge the experience and vision of the instructors in the various colleges and universities of the Pacific countries, making them thereby more competent and inspiring teachers, the exchange of teachers between institutions in different countries to be encouraged and made possible.

4. That a clearing house of information relative to opportunities for scientific study and research in the Pacific area be established.

5. That arrangements be perfected between the universities and other research institutions whereby properly qualified students may move from institution to institution carrying on their work at the place or places where the best facilities are available for the special kind of work upon which each may be engaged.

6. That a considerable number of fellowships be provided, with adequate stipends which shall be looked upon as compensation for the faithful performance of scientific work, and that especially able work by young investigators be rewarded by substantial prizes.

7. That to stimulate interest in the Pacific and inculcate a knowledge of its importance and unity, text-books should be prepared in which proper emphasis will be placed upon the Pacific area, its physical features, peoples, fauna, flora, resources and trade, and that the schools in Pacific countries be encouraged to give instruction which will stimulate the interest and enthusiasm of young students in the objects of their environment.

SCIENTIFIC EVENTS

DIMENSIONS AND AREA OF THE UNITED STATES

THE gross area of the United States is 3,026,789 square miles. The land area amounts to 2,973,774 square miles, and the water area—exclusive of the area in the Great Lakes, the Atlantic, the Pacific, and the Gulf of Mexico within the three mile limit—amounts to 53,015 square miles. These and other data determined or compiled by the United States Geological Survey, Department of the Interior, to show the limits of the continental United States contain some interesting facts.

The southern most point of the mainland is Cape Sable, Fla., which is in latitude 25° 07′ and longitude 81° 05′. The extreme southern point of Texas is in latitude 25° 50′, and longitude 97° 24′. Cape Sable is therefore 49 miles farther south than the most southern point in Texas.

A small detached land area of northern Minnesota at longitude 95° 09′ extends northward to a latitude 49° 23′.

The easternmost point of the United States is West Quoddy Head, near Eastport, Maine,

in longitude 66° 57′ and latitude 44° 49′; the westernmost point is Cape Alva, Wash., in latitude 48° 10′, which extends into the Pacific Ocean to longitude 124° 45′.

From the southernmost point in Texas due north to the forty-ninth parallel, the boundary between the United States and Canada, the distance is 1,598 miles. From West Quoddy Head due west to the Pacific Ocean the distance is 2,807 miles. The shortest distance from the Atlantic to the Pacific across the United States is between points near Charleston, S. C., and San Diego, Calif., and is 1,152 miles.

The length of the Canadian boundary line from the Atlantic to the Pacific is 3,898 miles. The length of the Mexican boundary from the Gulf to the Pacific is 1,744 miles. The length of the Atlantic coast line is 5,560 miles and that of the Pacific coast line is 2,730 miles. The Gulf of Mexico borders the United States for 3,640 miles.

Nearly all maps of the United States show the parallels of latitude as curved lines and are likely to lead the ordinary observer to believe that certain eastern or western states are farther north than some of the central states that are actually in the same latitude. For this reason, one who is asked which extends farther south, Florida or Texas, is very likely to say "Texas," but, as stated, the mainland of Florida is nearly 50 miles farther south than the southernmost point in Texas. For the same reason, when we consider the geographical positions of countries south of the United States we find that errors are likely to be made in estimating position or extent in longitude. Few realize that the island of Cuba, for example, if transposed directly north would extend from New York City to Indiana, or that Habana is farther west than Cleveland, Ohio, or that the Panama Canal is due south of Pittsburgh, Pa., or that Nome, Alaska, is farther west than Hawaii.

THE BRITISH DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

The following is a list of Research Associations which have been approved by the department as complying with the conditions laid down in the government scheme for the encouragement of industrial research and have received licenses from the Board of Trade:

The British Boot, Shoe and Allied Trades Research Association, Technical School, Abington Square, Northampton. *Secretary*—Mr. John Blakeman, M.A., M.Sc.

The Brittish Cotton Industry Research Association, 108, Deansgate, Manchester. *Secretary*—Miss B. Thomas.

The British Empire Sugar Research Association, Evelyn House, 62, Oxford Street, London, W.1. *Secretary*—Mr. W. H. Giffard.

The British Iron Manufacturers' Research Association, Atlantic Chambers, Brazennose Street, Manchester. *Secretary*—Mr. H. S. Knowles.

The Research Association of British Motor and Allied Manufacturers, 39, St. James's Street, London, S.W.1. *Secretary*—Mr. Horace Wyatt.

The British Photographic Research Association, Sicilian House, Southampton Row, London, W.C.1. *Secretary*—Mr. Arthur C. Brookes.

The British Portland Cement Research Association, 6, Lloyd's Avenue, London, E.C.3. *Secretary*—Mr. S. G. S. Panisset, A.C.G.I., F.C.S.

The British Research Association for the Woollen and Worsted Industries, Bond Place Chambers, Leeds. *Secretary*—Mr. Arnold Frobisher, B.Sc.

The British Scientific Instrument Research Association, 26, Russell Square, W.C.1. *Secretary*—Mr. J. W. Williamson, B.Sc.

The Research Association of British Rubber and Tyre Manufacturers, c/o Messrs. W. B. Peat & Co., 11, Ironmonger Lane, E.C.2.

The Linen Industry Research Association, 3 Bedford Street, Belfast. *Secretary*—Miss M. Burton.

The Glass Research Association, 50, Bedford Square, W.C.2. *Secretary*—Mr. E. Quine, M.Sc.

The British Association of Research for Cocoa, Chocolate, Sugar Confectionery, and Jam Trades, 9, Queen Street Place, E.C.4. *Secretary*—Mr. R. M. Leonard.

THE CENTENARY OF OERSTED'S DISCOVERY[1]

On August 31 and September 1 the centenary of the discovery of electromagnetic action by the Danish physicist, Hans Christian Oersted, was celebrated at Copenhagen. Meetings were held in the Town Hall and

[1] From *Nature*.

university, at which many Scandinavian men of science were present, and the occasion was marked by the publication of some of Oersted's scientific correspondence. It was during the winter of 1819–20 that Oersted observed that a wire uniting the ends of a voltaic battery affected a magnet placed in its vicinity, and after prosecuting his inquiries some months longer, in July, 1820, he published his Latin tract, "Experimenta circa effectum Conflictus Electrici in Acum Magneticum." The importance of his discovery received instant recognition. Ampère, Arago and Davy all seized on the idea, and four months after the publication of his tract Oersted was elected a foreign member of the Royal Society and awarded the Copley medal. Efforts to connect magnetism with electricity had hitherto met with little success, and Wollaston, in his discourse as president of the Royal Society, referring to Oersted's discovery, expressed the hope that "the gleam of light which thus beams upon us may be the dawn of a new day, in which the clouds which have hitherto veiled from our sight the hidden mysteries of light and heat, of electricity and magnetism, may be dispelled." Oersted, who was the son of a country apothecary, originally studied medicine, but turning his attention to chemistry and physics while at Copenhagen University, and he held that position until his death in March, 1851, at the age of seventy-three. Known alike for his genial and kindly nature and for his scientific labors, he was the author of some two hundred memoirs, and received many honors at home and abroad. Twenty-five years after his death a bronze statue of him was erected on the old fortification of Copenhagen.

THE NATIONAL COMMITTEE ON MATHEMATICAL REQUIREMENTS

THE National Committee on Mathematical Requirements held a meeting at Lake Delavan, Wisconsin, on September 2, 3 and 4, at which a number of reports were discussed and adopted. A report on The Revision of College Entrance Requirements received the greatest amount of discussion. It is hoped that this report may be released for publication early in October. It includes a general discussion of the present problems connected with college entrance requirements in mathematics, a report of an investigation recently made by the National Committee concerning the value of the various topics in elementary algebra as preparation for the elementary college courses in other subjects and a suggested revision of the definitions of entrance units in elementary algebra and plane geometry. A copy will be sent to any person interested upon application to the chairman of the committee, Professor J. W. Young, Hanover, N. H.

A preliminary draft on mathematics in experimental schools was discussed at this meeting. Mr. Raleigh Schorling of the Committee has spent over a year collecting material for this report. Miss Vevia Blair of the committee presented her report on the present status of disciplinary values in education. It is expected that this report also will be released for publication in October. It gives a critical review of the complete literature concerning the experimental work on the transfer of training.

Professor E. R. Hedrick presented a report which he prepared at the request of the National Committee on "The Function Concept in Secondary School Mathematics." This report also will be published in the near future.

A preliminary report on junior high school mathematics is in the press of the U. S. Bureau of Education and should be ready for distribution early in October. A subcommittee under the chairmanship of Professor C. N. Moore in preparing a report on "Elective courses in mathematics in secondary schools." A committee under the chairmanship of Professor David Eugene Smith is preparing a report on "The standardization of terminology and symbolism" and Professor R. C. Archibald is preparing one on "The training of teachers." It is expected that all three of these reports will be presented for the consideration of the national committee in October.

SCIENTIFIC NOTES AND NEWS

The First Pan-Pacific Scientific Conference closed its three weeks session at Honolulu on August 20. Delegates were present from Australia, Canada, China, Japan, New Zealand, Peru, the Philippines, Samoa and from several scientific organizations and Federal Bureaus of the United States. The proceedings of the conference are to be published by the Bishop Museum under the direction of a committee consisting of Dr. Arthur L. Dean, president of the University of Hawaii, Dr. Herbert E. Gregory, Yale University, Dr. T. Wayland Vaughan, United States Geological Survey and Dr. Henry S. Washington, Geophysical Laboratory. This committee announces that the daily proceedings of the conference, including the discussions and the resolutions adopted, will be issued shortly and that the detailed programs of research in various branches of science will appear early in 1921.

Dr. Charles MacFie Campbell, assistant director of the Henry Phipps Psychiatric Clinic, Johns Hopkins Hospital, has resigned to become professor of psychiatry at Harvard Medical School and director of the Boston Psychopathic Hospital. Dr. Campbell will assume his new work on October 1.

Dr. Oliver Kamm, of the chemistry department of the University of Illinois, has been appointed director of the Chemical Research Department of Parke, Davis & Co.

Dr. C. D. Sherbakoff, hitherto truck pathologist at the Florida Agricultural Experiment Station, Gainesville, has accepted the position of station pathologist at the Tennessee Agricultural Experiment Station, Knoxville.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. Harry Beal Torrey has resigned from the faculty of Reed College to become professor of zoology and director of fundamental education in medical science in the University of Oregon. He will divide his time between Eugene and the School of Medicine in Portland. An attempt will be made to bring together in one course the premedical and medical years and to obliterate the divisions commonly existing between premedical, preclinical and clinical studies.

At Tulane University the following appointments have been made: Dr. D. S. Elliott, head of the department of physics in the Georgia Institute of Technology, professor of physics; Dr. S. A. Mahood, chemist of the Forest Products Laboratory of the University of Wisconsin, associate professor of chemistry, and Dr. Herbert E. Buchanan, professor of mathematics in the University of Tennessee, professor of mathematics.

Dr. Lane has been appointed clinical professor of dermatology in the Yale Medical School and Dr. Alfred G. Nadler has accepted a similar position These two physicians will divide between them the work heretofore carried on by Dr. Ralph A. McDonnell, resigned.

Dr. C. McLean Freaser has been appointed professor of zoology in the University of British Columbia, at Vancouver.

The chair of chemistry in Berlin University, rendered vacant by the death of Emil Fischer, will be filled by Professor Fritz Haber, who will retain also his present position of director of the Emperor William Institute for Physical and Electro-Chemistry.

DISCUSSION AND CORRESPONDENCE

MIRAGES?

To the Editor of Science: I have frequently observed the phenomenon described by F. W. McNair in Science for August 27. Contrary to the assumption of Mr. McNair, however, it may be observed under any conditions of weather and temperature. I have seen it ahead many times while driving an automobile over concrete and tar-surfaced roads. There can be little doubt that it is a phenomenon of simple reflection and is therefore entirely independent of atmospheric conditions. Any compara-

tively rough surface seems to act as a polished mirror toward light striking it at a very small angle of incidence. The mirage on the plains, being a phenomenon of refraction, is of an entirely different nature.

H. H. PLATT

TO THE EDITOR OF SCIENCE: In his communication to the issue of August 27, Mr. F. W. McNair touches upon a matter which seems to me worthy of further consideration.

In the course of numerous trips about the country by automobile, I have had repeated occasion to note the sort of mirage mentioned, particularly on stretches of surfaced road. The phenomenon commonly takes the form of an apparent small pool of water, which appears suddenly a little way ahead, and disappears with equal suddenness.

In most cases the reflecting air-surface would appear to be only a few inches above the road: the effect is that of a shallow pool, and one involuntarily dodges the apparent depression. On one or two occasions, however, I have noted a reflecting surface high enough to cut off the wheels of a vehicle driven through the lower stratum of air.

It occurs to me that the condition suggested may serve in part to account for ideas of temporary disappearance, or dematerialization, of solid objects, and for occasional accounts of apparent hallucination.

This matter would seem to be interesting and important enough to warrant fuller discussion.

FREEMAN F. BURR

RATTLESNAKE ISLAND, past which Perry sailed his fleet to the battle of Lake Erie in 1813, lies two miles northwest of Put-in-Bay and occupies about eighteen degrees of the horizon.

On Sunday, July 18, at about one o'clock, while watching a thunderstorm approach over Rattlesnake, a second island was seen, somewhat higher than the real one and shifted to the westward approximately one third the apparent length of the island.

At first this was thought to be a mirage of Middle Sister which lies some miles to the northwest. Two small islets, the Rattles, which lie off shore from the western end of Rattlesnake and which were projected to the left of the phantom island, indicated, however, that we were looking at an image of Rattlesnake.

The apparition was seen from a cottage three hundred yards to the southwest as well as from the laboratory cottage. It persisted for some time, possibly as long as fifteen minutes, disappearing just before the sheets of rain from the storm blotted out Rattlesnake entirely. The outline of the real island was at all times more distinct than that of the image, which was—or seemed to be—slightly behind it as well as above.

STEPHEN R. WILLIAMS

LAKE LABORATORY,
OHIO STATE UNIVERSITY,
PUT-IN-BAY, OHIO

FAMILY AND SUBFAMILY NAMES IN ZOOLOGY

TO THE EDITOR OF SCIENCE: I have read with much interest Oberholser's thirteen rules for family and subfamily names appearing in the issue of SCIENCE of August 13, 1920, which he says have the approval, in part at least, of thirteen named persons well known for their work in systematic zoology. If Dr. Oberholser had stopped with number 12 his rules would appear to be quite ideal.

Why rule 13? Two family or subfamily names having the same spelling are comparatively rare. They are for the most part going to be used by persons who know what the type genera are. It is quite inconceivable that there would ever be any real confusion because of identical spellings. If it is desirable to distinguish between two families or subfamilies that would be spelled alike by following rules 1 and 2, a prefixed *Pro* seems to me to be the least desirable method. Any one not familiar with the case would naturally think the type genus of *Propicidæ* to be either *Propicus* or *Propica*. In Palmer's "Index Generum Mammalium" there are over 100 generic or subgeneric names beginning with the prefix *Pro* and at least half a dozen of these names are used in forming family or subfamily names.

The simplest method to distinguish between two family or subfamily names that would otherwise be spelled alike, would seem to be to add *idæ* or *inæ* to the full generic names in the few cases in which duplication would occur, as *Picaidæ and Picusidæ*. Other expedients would be to write *2d* after the later name, or the year in which the name was published, or the Greek letter β. To make a prefix as *Pro* a part of the family or subfamily name and so cause the name to appear in alphabetic lists far away from its logical place and to lead the uninitiated into thinking of a *Pro* genus which does not exist seems as absurd as it is unnecessary.

M. W. Lyon, Jr.

THE NEEDS OF MEN OF SCIENCE IN RUMANIA

To the Editor of Science: Please publish in Science the following extract from a letter of Professor Marinesco, a leading scientist and physician in Rumania.

. . . . I believe that our American colleagues, whose country made such a noble contribution to victory, ought to take notice of the unhappy state of the Rumanian men of science which is due to the occupation of our country by the enemy. It is probably unknown that after the occupation we were in extreme distress, because all our instruments were then taken away or destroyed. A part of our libraries has been destroyed. Furthermore, since Rumania has no chemical industries, we do not possess the chemical reagents, etc., indispensable for scientific research. Allied European countries which would aid us, France for instance, have been equally devastated.

Perhaps the United States which has contributed so largely to the restoration of Europe would make a grand gesture and help the investigators of our country by sending some instruments and a certain amount of reagents as far as they are able to do so. They can not be accepted gratuitously; but we believe that we will be able to repay the debt later when the unfavorable exchange no longer weighs so heavily upon our laboratory budgets.

Hoping that my prayer will find a favorable response among my American colleagues, we would like you to be our spokesman.

S. J. Meltzer

Rockefeller Institute, New York,
September 1, 1920

QUOTATIONS

SCIENCE AND THE PUBLIC

This is the heading of a leaderette in the *Daily Mail*, which states that "Light is to be 'caught bending' next week at Cardiff." It goes on to say that "We have in Britain today as original a group of scientific men as any country in the world; and they are beginning at last to see the wisdom of coming out of their caves and laboratories and applying their brains to practical affairs; to the laws that govern heredity, to wireless apparatus, to the uses of alcohol, to the migration of fish, to medicinal thought-reading, to the possibilities of intensive cultivation—which bulks largely this year—indeed to scores of practical themes to which their more abstract studies are leading.

"In any case, it is time most profitably spent if for one week in the year our men of science bend their united energies to the work of interesting the public in the advance of science. It is as much the duty of the public to appreciate the men of science as of men of science to come to meet the public."

Now, what does the *Daily Mail* think "our men of science" had been doing during the period before they began to see the wisdom of coming out of their caves and applying their brains to practical affairs? Does it really think that they have suddenly awakened and hurriedly worked up papers on the laws of heredity, on wireless apparatus, etc., just for the purpose of interesting the public during this British Association week?

The *Mail* speaks of "our men of science" with a patronizing air, a kindly condescension which implies that they are rather weird uncanny folk, not quite normal, who dwell in "caves and laboratories," and do not usually apply their brains to practical affairs—so unlike the brainy trumpeters of the daily press, who gaily talk of "catching light bending" without having the faintest conception of the significance of the allusion. This superior attitude of the journalist who, in many cases, can not even write English correctly, and whose mind is blankly opaque to the most elementary notions of physical science, is galling to those

who are able to appreciate the nature and value of the work of that band of British scientific heroes, without whose efforts, the result of long years of patient training in research, the war would inevitably have been lost, on the land, on the sea, and in the air. If the lay press would descend from its wooden pedestal and inculcate in the public mind that knowledge and love of science through which "our men of science"—unexcelled in the whole world—acquired their equipment for winning the war, instead of perpetuating the silly and antiquated notion that they are habitually immersed in useless hobbies of no practical utility, it would do real service to the country.—The London *Electrical Review*.

NOTES ON METEOROLOGY AND CLIMATOLOGY

TORNADOES

A FEW weeks ago an official of the Weather Bureau was asked this question: How many tornadoes will a healthy cyclone hatch in a day? This, naturally, was a difficult question to answer; but it must be admitted that the tornadoes of March 28, in the middle western and southern states, and those of April 20 in Mississippi, Alabama and Tennessee, afford striking examples of the fecundity of barometric depressions when other conditions are favorable. The *Monthly Weather Review*[1] for April, 1920, contains about 18 papers, discussions, and notes concerning these very destructive tornadoes, as well as those which occurred in North Carolina and Oklahoma on April 12 and May 2, respectively.

Eleven of the thirteen tornadoes of March 28 occurred in the region surrounding lower Lake Michigan and two occurred in western Alabama and eastern Georgia. It appears that they were associated with the passage of the squall front or line of wind-convergence which marked the barrier, in the southeastern quadrant of the deep "low," between southeasterly and southwesterly winds. The "low" which gave rise to this wind-shift line moved from east-central Nebraska to northern Wisconsin in the course of the day. In the region of lower Lake Michigan, it was possible to trace the hourly progress of the line as it advanced on a slightly curved front in a general east-northeasterly direction. It appeared at 6 A.M. in northeastern Missouri and southeastern Iowa; at noon, it extended along the eastern line of Illinois northward to the lake, thence curving northwestward into Wisconsin; at 9 P.M., it had almost reached Lake Huron, and was over the western end of lake Erie. As its northern end reached Lake Michigan, there was a perceptible forward bulge which may be attributed to the decreased friction as the wind advanced over the smooth water surface.

Regarding the circumstances under which these tornadoes were formed, Dr. Charles F. Brooks, in his discussion, says:

> Why did these 13 tornadoes occur on the afternoon of March 28? Let us review the facts as brought out by the weather observations:
>
> 1. There were strong, unusually warm winds from the southeast and south-southeast over a large area from the Gulf of Mexico to the Great Lakes.
>
> 2. A well-marked line . . . separated these winds from still stronger, but slightly cooler southwest or south-southwest winds in a belt immediately to the west.
>
> 3. Heavy thunderstorms, some with tornadoes and hail, occurred along this line of converging winds.
>
> 4. Immediately to the west of the northern portion of this line was a belt of diverging winds, characterized by brilliantly clear skies and exceedingly dry air, the driest on record at some stations. . . .
>
> 5. Kite observations indicated the presence of a cold southwest-west wind at a moderate height overrunning the warm surface wind.
>
> 6. The northeasterly movement of the tornados and lower clouds and the fall of hail on or to the east of the tornado paths indicated a southwest to, at least, west-southwest wind not far aloft.

Surely this was an unusual set of conditions. With winds meeting at an angle of about 60° and at a rate of about 30 miles an hour, large volumes of air were sent upward and given a counter-clockwise rotary motion by the thrusts of the southwest squalls routing under the rear portions of the

[1] Papers on tornadoes, pp. 191–213. Reprints of these papers may be obtained upon application to the Chief, United States Weather Bureau, Washington, D. C.

slower north-northwestward-moving masses of warmer air. At a moderate height condensation took place in the moist, upthrust air, and as it ascended at a lesser rate of cooling, due to the liberation of the latent heat of condensation, it probably was squeezed aloft at an increased rate by the cold wind it was probably encountering. Under such conditions intense vertical movement accompanied by a rotary motion of small dimensions makes a tornado.

The circumstances surrounding the formation of the tornadoes of April 20 were somewhat different. In this case, there was a long, oval-shaped low pressure area over the southern part of the Mississippi valley. The storms occurred in the morning at a time when the line of wind-convergence was a considerable distance to the west of the line of tornado formation. Therefore, it can not be said, as in the previous case, that the mechanical effect of the wind-shift line was operative. There is another striking feature: All of these whirls were formed along a north-south line which lay about 30 miles west of the Mississippi-Alabama line. The first occurred at Ingomar at 7:30 and followed a northeasterly course into Tennessee where it continued by a series of dips almost to the center of the state. The second began about 40 miles south of the first, near Bradley at 8:00 A.M. and moved northeastward, disappearing in northcentral Alabama. The third began near New Deemer, at 8:30 A.M. and ended near Brownsboro, Alabama. (This was the longest of the four paths, and was marked by an almost continuous swath of destruction for 150 miles.) The fourth appeared at Bay Springs at 9:55 and ended near the state line east of Meridian, having passed within a mile of the Weather Bureau office at that place. The significant facts are, (1) that these tornadoes formed on a nearly north-south line, and (2) that they formed at almost equal intervals of time and distance. The probable explanation is that these formations resulted when an overrunning layer of cold air arrived over a given place, where other conditions were favorable, increasing the vertical temperature gradient to such a degree that there was immediate and intense convection. That this advancing front was probably coming from the northwest is shown by joining the positions of the tornadoes at any given time. The resulting line is normal to the wind direction supposed to exist aloft.

According to Mr. J. H. Jaqua, the Weather Bureau meteorologist at Meridian, Mississippi, the passage of the tornado at that place was accompanied by almost total darkness. He says:

> . . . The darkness between 10:30 and 10:39 A.M. was as intense as would be common for a cloudy moonless night at 9:30 or later, and though lights were on in the business houses (but no street lights were in operation), pedestrians could distinguish each other only with great difficulty. . . . The pall of darkness was so unnatural that it was extremely weird. . . .

No account of tornadoes is complete without the recital of some of the many "freaks" which such storms are wont to perform. The removal of feathers from chickens, the complete destruction of houses, the clean sweeping through deep forests, and the carrying of objects great distances, are examples frequently recounted. Of the many curious pranks of these storms, however, there are some which are worthy of mention. Here are some excerpts from the numerous accounts in the article cited above:

> An automobile locked in a garage was undamaged, although the garage was blown to splinters.
>
> Half a dozen glass jars of fruit were carried 100 yards by the winds and not damaged. (*Bay Springs, Miss.*)
>
> A car load of stone was whipped about like a feather, and trees, one especially large oak, were twisted from the roots as if they had been bits of wire. (*Florence, Ala.*)
>
> There seemed to be two puffs of wind; one carried things toward the west. In about a quarter of a minute everything came back. I tried to keep my family down on the floor. One of my boys blew out of the house; then blew back. . . . (*From report of J. P. Sanderson, Newburg, Ala.*)
>
> [The tornado] swept rapidly across the cove, . . . as it neared the mountain range and went over it, leaving a path clear of any standing timber, houses, or fences. In going over the path of

the storm the next day . . . cedar trees, with trunks 16 inches through [were found] lying on the upper benches of the mountain, that had been torn up by the roots down in the valley and brought up bodily and deposited among the big timber on top of the range. . . . (*Postmaster Okal, Huntsville, Ala.*)

. . . A mule was hurled 100 feet against a tree stump, its body pierced by a 2 by 4 scantling; a horse was carried several hundred feet into a patch of wood where it was found the following morning apparently unhurt; a steel range from the Preston home was found 3 miles away in a wheatfield; harrows, plows and other agricultural implements were scattered over the -fields for miles around; a sewing machine was found hanging from a tree limb. . . . (*Occurred in the tornado of April 12, in Union County, N. C., according to Mr. G. S. Lindgren.*)

This list could be continued indefinitely, and it is presumed that each locality visited could yield a number of remarkable "freaks."

The series of articles in the *Review* is concluded by a reprint from the "Physics of the Air,"[2] by Dr. W. J. Humphreys on the "Tornado and its cause," and a bibliography prepared by Professor C. F. Talman, which gives the principal publications containing statistics of tornadoes in the United States.

It is needless to say that the twenty-one or more tornadoes which have been experienced in the United States this spring, have been terribly destructive of life and property. It is estimated that in the tornadoes of March 28 killed 163, injured several hundred and destroyed ten million dollars worth of property. Those of April 20 were even more destructive of life, there being 229 deaths reported and over 700 injured, with a property loss also extending into the millions. This most destructive of storms is so extremely local that even though there may be a wind speed of between two and five hundred miles per hour in the funnel-cloud, this speed falls off so rapidly with distance from the center that the wind may not even be of destructive violence within a few hundred yards. Owing to this extreme localization, the tornado can not be accurately forecast; and if it could, it is so violent that no precautions could be taken except these already observed in localities where it frequently occurs—namely, keeping in readiness the storm-cave.

C. LEROY MEISINGER

WASHINGTON, D. C.

[2] *Journal of the Franklin Institute*, January, 1918, pp. 114–116.

SPECIAL ARTICLES

THE SOUNDS OF SPLASHES

UNDER the above title an interesting note has just been published by Professor C. V. Raman and Mr. Ashutosh Dey.[1] The authors call attention in a footnote to the fact "that the splash of a liquid drop is practically soundless unless the height of fall exceeds a certain minimum." In connection with this remark it seems perhaps worth while to publish a note on a preliminary study of a similar problem which I made in 1915. I have been intending to return to the work, but have been giving my attention to other matters.

My observations were confined to drops of water falling into water, and were made by ear. They indicate not only a single minimum height of fall within which the drops strike the water silently, but also other greater heights of fall for which the drops enter the water without sound. The boundary between a region in which a drop makes a sound when it strikes and a region in which it does not make a sound when it strikes is very sharp, a fraction of a millimeter difference in the height of fall being sufficient to pass from a drop which falls silently to one which makes a sharp click when it strikes.

In the figure the results of five experiments are shown. The numbers at the left give the distances in centimeters from the orifice from which the drop fell to the surface of the water below. Each vertical line indicates a range throughout which the drops click when they strike the water. The maximum heights of fall tried are indicated by the horizontal dotted lines.

It will be seen that in most cases a drop strikes silently if it falls less than about 5.5 cm., if it falls more than about 7 cm. but less

[1] *Phil. Mag.* (6), 39, p. 145, January, 1920.

than 8 cm., or if it falls more than 11 cm. With increasing size of drop all of these distances increase. Thus the lower limit of the range of sounding which is marked *A* on the figure is about 7.0 cm. for a drop which has a mass of 45 mg., but is between 7.7 cm. and 7.8 cm. for a drop which has a mass of 49 mg.

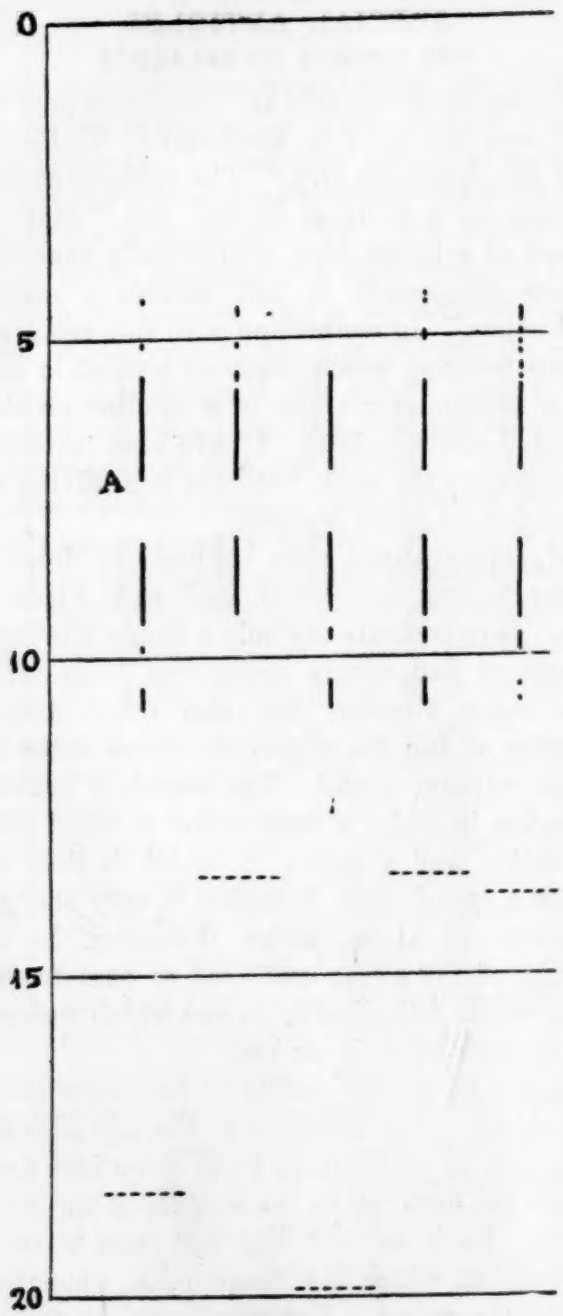

Fig. 1.

The depth of the water into which the drop falls makes no difference so long as this depth exceeds about three centimeters. The horizontal distance from the boundary of the water surface to the point at which the drop strikes makes no difference so long as this distance is more than about a centimeter. The depth of the water surface below the top of the containing vessel appears to be without effect.

Instead of the characteristic sharp click of the drop there was occasionally a softer, duller sound, and when this soft sound occurred the drop often left a bubble at the point where it had struck. In the case of the click no bubble was usually left.

I have no explanation to suggest for this series of sounds. If they depended on the shape of the drop when it struck the water we should not expect an abrupt boundary between the regions of sounding and the regions of silence, and we should expect the series of regions to repeat at distances proportional to the squares of the successive integers.

Arthur Taber Jones
Smith College

The Crystal Structure of Ice

X-ray photographs of ice were taken to determine its crystal structure following the method used by A. W. Hull.[1] The lines on the film correspond to those of the hexagonal system. They show that ice has a lattice which is built up of two sets of right, triangular prisms interpenetrating one another in the following way. Consider the plane containing the bases of one of the sets of prisms. The molecules lie at the vertices of equilateral triangles of side 4.52 Ångstroms. At a distance of 3.66 Ångstroms above this plane lies the plane containing the bases of the second set of prisms. Here the molecules also lie at the vertices of equilateral triangles equal to those of the first set, but each molecule is situated directly above the center of one of the lower triangles. The other molecules of the crystal will lie directly above the molecules of the two planes just described at intervals of 7.32 Ångstroms. The above values give an axial ratio of 1.62 in good agreement with the crystallographer's value of 1.617.[2] From

[1] *Phys. Rev.*, 9, 85, January, 1917.

[2] Gmelin Kraut, "Handbuch der Anorganischen Chemie," Heidelberg, Vol. I., 1, p. 107, 1907.

these data the number of molecules at each point has been calculated to be two.

This means that the molecule of ice must be of the form $(H_2O)_2$ or H_4O_2. The full data and calculations will be published in the *Physical Review.*

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SCHENECTADY, N. Y.,
August 20, 1920

THE AMERICAN CHEMICAL SOCIETY. VIII

RUBBER DIVISION

W. K. Lewis, *chairman*

Arnold H. Smith, *secretary*

Discussion of report of committee on "Physical Testing."

A direct method for the determination of rubber hydrocarbon in raw and vulcanized rubber: W. K. LEWIS and W. H. MCADAMS. It has been shown by a volumetric method involving a double titration that the bromine consumption, corrected for the observed substitution is a true measure of the actual amount of pure rubber hydrocarbon known to be present. Although the amount of substitution increases with the length of the bromination period, the addition corresponds quantitatively to the actual amount of pure rubber hydrocarbon present when the bromination time is from two to four hours. Experimental data is given to show that the actual per cent. of $(C_{10}H_{16})n$ in vulcanized soft rubber can be determined by a volumetric bromination method herein described, involving a second titration to correct for the substitution which accompanies the particular analysis by titrating in dim daylight, this substitution correction can be made very small.

The value of shoddy in mechanical rubber goods: J. M. BIERER. A chart was presented which gave the cost relations between scrap rubber and reclaimed rubber. The value of this reclaimed rubber was evaluated on a basis of tensile strength and compared to a corresponding priced new rubber. A line of demarkation through the center of the chart showed where it was more economical to use new rubber or reclaimed rubber.

The recovery of volatile solvents: W. K. LEWIS. Solvents used in the rubber industry may be recovered by the use of any method such as absorption, compression or cooling. Ordinarily in the rubber industry the solvent vapor is diluted with a large quantity of air and in this case the absorption method is best. When such conditions are present so that one has concentrated vapors a compression method becomes available. Benzol used in pregnating cord tire fabric may be recovered with an efficiency of 90 per cent. by enclosing the impregnating apparatus and passing the vapors through an absorption tower. The danger of fire or explosion may be eliminated by passing flue gas into the apparatus.

On the determination of true free and true combined sulphur in vulcanizing rubber: W. J. KELLY. At present sulphur is considered as free and combined. Acetone soluble sulphur may be partly combined with resins, etc., as may also the sulphur insoluble in acetone, heretofore considered as combined with rubber. The total acetone extract is soluble in EtOH, but if EtOH saturated with sulphur is employed, none of the truly free sulphur will dissolve and hence can be separated from the remainder of the extract. Results show about 0.4 per cent. sulphur combined with resins, etc. About 85 per cent. of Heva resins are saponifiable and hence any resinous sulphur compounds insoluble in acetone may be soluble in alc. KOH. Acetone extracted sample is boiled 8 hours in 5 per cent. alc. KOH and about 0.26–0.30 per cent. sulphur extracted. Successive extractions do not increase this. Hence, the rubber is not being decomposed. These results are on pure gum and sulphur stocks and will be extended to compounded stocks later.

Analytical determination of the coefficient of vulcanization: S. W. EPSTEIN.

Small amounts of magnesia and certain organic substances as accelerators: G. D. KRATZ and A. H. FLOWER. The activity of small amounts of extra light magnesia as an accelerator was compared with the effect of similar amounts of certain organic accelerators. The load required to effect a given extension was found to be a fair measure of the rate of cure of the mixture which contained magnesia; however, this was not true for the mixtures which contained the organic accelerators. The accelerating activity of magnesia in small amount was found to be of secondary or contributory, character, acting in conjunction with, or in response to, certain extraneous substances, probably nitrogeneous, present in the rubber. The amount and nature of these extraneous substances was found to limit the activity of magnesia as an accelerator.

Diffusing power of pigments: W. K. Lewis and F. P. Baker. The diffusing power of pigments can be determined by measuring the weight of pigment per unit of cross sectional area necessary to obscure objects behind a suspension of the pigment, the result being expressed as square centimeters per gram or square feet per pound. The determination can be carried out in simple apparatus and results can be checked with accuracy. It is believed that the diffusing power is the most satisfactory measure of the fineness of a pigment, and as such is of obvious interest and value to the rubber trade.

The effect of compounding ingredients on the physical properties of rubber: C. Olin North. Compounding experiments in which from one to fifty volumes of filler, *i. e.*, gas, black, zinc oxide, etc., were added to 100 volumes of rubber are described. The values obtained for tensile strength, etc., are corrected back to the actual volume of rubber present and another set of curves drawn. Tensile strength calculated on area at rest is unfair to a soft stretching stock. Tensile at break is suggested as a better basis of comparison. This is obtained by multiplying usual tensile strength by final length and dividing by the original length times a correction factor, because of volume increase during a stretching. A visual picture of the physical structure of rubber, *i. e.*, network hypothesis based on the assumption that large colloidal aggregates function as elastic fibres and the smaller as plastic material is presented. Vulcanization probably locks up these fibers to form a network.

The microscopic examination of rubber and rubber products: Henry J. Masson and Irene C. Diner. The authors presented the results of their investigation in the line mentioned in the title. Magnifications of from 500 to 2,000 diameters were used. Best results were obtained at magnifications of about 800 diameters. The ordinary methods of metallurgy were resorted to, both oblique illumination and vertical illumination being used. Photomicrographs were shown at the meeting of various samples which had been examined.

Rubber chemistry from the colloidal viewpoint: Ellwood B. Spear. The mechanism of crystallization, condensation, polymerization and coagulation was discussed. Gelation is one type of coagulation. Selective adsorption is given as a reason for the increased tensile strength of compound rubber. This deals with the different surface energy of rubber and the various compounding ingredients.

LEATHER CHEMISTRY SECTION

Louis E. Levi, *chairman*

William Klaber, *secretary*

The true tanning value of vegetable tanning materials: John Arthur Wilson and Erwin J. Kern. A new method of tannin analysis is described which determines exactly what is called for in the generally accepted practical definition of tannin, namely, that portion of the water-soluble matter of certain vegetable materials which will precipitate gelatin from solution and which will form compounds with hide fiber which are resistant to washing. The analyses of 10 common tanning materials by the new method and by the official method of the American Leather Chemists' Association indicate that the latter method is in error to the extent of from 43 to 220 per cent. The new method gives reproducible results and is considered entirely practicable.

The neutral salt effect and its bearing upon leather manufacture: John Arthur Wilson and Edwin A. Gallun. The addition of neutral salts to the various liquors used in making leather is shown to have the effect of increasing the activity of all the constituents of such liquors, whether they be acid or alkaline. In the case of chloride salts, this was shown quantitatively to be due to removal of solvent by hydration of the added salt. The results of 37 experiments in chrome tanning with different kinds and proportions of neutral salts are given which throw considerable light upon the mechanism of chrome tanning.

The determination of sulfate in sulfonated oils: Erwin J. Kern. In the determination of uncombined sulfate in sulfonated oils, the use of organic solvents can be dispensed with, if the usual brine solution be replaced by a 10 per cent. solution of monosodium phosphate, which gives a clear separation of solution and oil in very few minutes. After boiling the oil with hydrochloric acid, total sulfate may be determined in the same way. The phosphate solution extracts all of the sulfate in each case, which may then be determined as barium sulfate in the usual manner. A saving of time is effected by the new method.

A new method for the determination of sulfuric acid in leather: Arthur W. Thomas.

Time factor in the adsorption of the constituents of chromi sulfate solutions by hide substance: Arthur W. Thomas and M. J. Kelly.

The conductivity titration of chrome liquors: ARTHUR W. THOMAS and S. B. FOSTER.

Physico-colloidal interpretations of the tanning and tawing procedures: I. NEWTON KUGELMASS.

The currying of leather for belting: EDWARD E. MARBAKER.

Chemical work in the tannery: LOUIS E. LEVI.

SUGAR SECTION

C. A. Browne, *chairman*

Fred. J. Bates, *secretary*

Chemical control in the beet sugar industry: S. J. OSBORN.

The testing of saccharimeters by means of the telescopic control tube: C. A. BROWNE. Uses of the control tube are described (1) for determining the errors of saccharimeter scales, (2) for comparing scales, (3) for determining sensibility of saccharimeters, (4) for testing ability to polarize accurately, (5) for determining influence of personal equation. The maximum scale error on good instruments was found not to exceed 0.04° v. The probable error of a single reading on a German saccharimeter was ± .05 and on a Bohemian ± .03 or an average of ± .04. Personal equation may produce a constant one way difference of ± .04 between different observers. Reversing the optical construction of saccharimeters was found to reverse the order of personal equation. Disputes about the values of normal weights no doubt result partly from personal equation.

Observations upon the use of different types of saccharimeters: C. A. BROWNE. Observations are given of the good and bad features noted in the practical use of saccharimeters of American, English, French, German and Bohemian manufacture. The advantages and disadvantages are presented of the open and closed construction types of instruments, of the various forms of polarizers, of different kinds of saccharimeter scales, and their comparative accuracy, and of differences in methods of illumination, trough construction and other details. As a result of his inspection the author believes the outlook for the manufacture of accurate saccharimeters in countries outside of central Europe is most encouraging.

The filteration of sugar-juices and syrups: WALTER L. JORDAN.

The clarification of cane juice without chemical treatment: F. W. ZERBAN. Previous investigators have found that nearly three fourths of the impurities which are removed by treatment of cane juice with heat and lime, can be taken out by filtration in the cold, and that therefore the chemical effect of the lime treatment plays only a small part in clarification with this process. It was also shown by the same investigators that the greater part of these impurities exist in the juice in colloidal form. Conclusions based on these facts are further developed in this paper, and it is pointed out that the effectiveness of the various chemical clarification methods at present in use may in their broad outlines be explained by colloid-chemical considerations. It is very probable that surface energy, and particularly adsorption, is the principal factor in these classification processes. It follows from these theoretical considerations that cane juice clarification may be brought about without the use of any chemicals whatever, but simply by the use of efficient adsorbents. Laboratory and factory tests have given strong evidence that this is actually the case, and it was found that in comparison with the sulfitation process, at least the same quantity of first sugar of greatly superior quality can be made by clarification with one half per cent. Filter-Cel, followed by treatment with 1 per cent. Norit, and filtering the juice in both cases, which is easily and rapidly done. The first molasses is so very light in color that the recovery of high-grade sugar can probably be materially increased, still leaving a molasses of higher market value than that made by the usual plantation methods.

The Hess-Ives tint-photometer and its use with raw sugars: GEORGE P. MEADE and JOSEPH B. HARRIS. The scale readings of the Hess-Ives Tint-Photometer are meaningless in themselves as they do not express directly the relative amounts of color. It was found that the scale readings for solutions containing 1, 2, 3, 4, etc. units of material run in powers of the reading for one unit, considering the scale readings as decimal fractions. This is due to the mechanical make-up of the instrument, and is true no matter which color screen or what class of material is used. Expressed algebraically, this relationship between the scale readings and the amounts of color becomes $y = K^x$, where y is any scale reading, K is the reading for one unit of material, and x is the number of units of material required to give the scale reading y. By means of this equation solved for x the color of two materials may be compared, given scale readings for equal quantities; or all scale readings may be compared to a standard. To avoid the repeated calculations, a table has

been calculated which gives the units of color corresponding to each scale reading from 100 to 1. A convenient method for determining the color of raw sugars, using the table, is given together with results for various sugars.

The deterioration of Cuban raw sugar in storage: Nicholas Kopeloff and H. Z. E. Perkins. From the results indicated below, a correlation between the number of microorganisms and the moisture ratio is indicated which appears to make it possible to predict the keeping quality of a sugar by a preliminary bacteriological and a chemical analysis. Cuban raw sugars (with moisture ratios varying from .22 to .49) were stored under normal conditions in a large warehouse for 5½ months and analyzed chemically and bacteriologically. There was a loss in polarization at the end of this period, as well as at the end of one month, which was generally accompanied by a gain in reducing sugars. Likewise a gain in moisture content and reduction in the factor of safety was noted. There was a decided increase in total number of microorganisms after one month, which could be correlated within certain limitations with deterioration. Where there was a large initial infection, deterioration was rapid. In general there were more microorganisms in the middle of the bag than at the surface. Bags designated as wet, stained or having sugar light in color, deteriorated more rapidly than when drier, unstained or dark in color. In bags of sugar which are deteriorating rapidly, the surface deterioration is greatest, while in less rapid deterioration the middle of the bag seems to undergo greater decomposition. Deterioration was found to be proportionately greater over a longer incubation period than in one month.

The development of the polarimeter: Noel Deerr. A brief account is given of the development of the polarimeter beginning with the earliest instrument of Biot and continuing with the subsequent improvements of Nicol, Ventzke, Mitscherlich, Soleil, Duboscq, Jellet, Cornu, Laurent, Lippich and others. The three major inventions in this development are the prism of Nicol, the quartz wedge compensator of Soleil and Duboscq, and the photometric end-point of Jellet. German science has contributed nothing elementary to this development, although the manufacture of polarimeters has been allowed to become almost exclusively Teutonic.

Changes in the analytical ratios of sugar during refining: A. F. Blake.

Boneblack and decolorizing carbons: W. D. Horne. Investigators of Boneblack and decolorizing carbons should bear in mind the practical working conditions to be met by these substances. Boneblack or substitutes should exist in grains of 16 to 30 mesh and should be hard, very porous and high in absorptive power for iron as well as for coloring substances. Carbon is not necessarily a constituent, and a more easily cleansed and revivified substance is needed. Decolorizing carbons need to be more absorbent of ash and of red coloring matters such as caramel, and cheap enough to discard after using a few times.

The production of the gum, levan, by mold spores: Nicholas Kopeloff and Lillian Kopeloff. Mold spores contain an enzyme capable of forming gum in sugar solutions of all concentrations up to the saturation point. Pure gum was obtained by precipitation with five volumes of alcohol in alkaline solution and the specific rotation found to be about —40. Upon hydrolysis with acid, levulose was formed. Its melting point was about 200° C. The gum was considered to have properties identical with levan, previously noted in the bacteriological decomposition of sugars by Greig-Smith and Owen. A new method of determining levan and actual sucrose in sucrose solutions was established by using the invertase method (pure invertase solution prepared from yeast) in conjunction with the usual Clerget procedure. Some data have likewise been obtained which indicate the nature of the sugars from which levan is formed.

The determination of moisture in beet sugar factory products: V. L. Aikin.

Charles L. Parsons,
Secretary

(*To be continued*)

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